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**RELATIONSHIP BETWEEN COMPUTER-BASED HYPERTENSIVE RETINOPATHY GRADING AND CARDIOVASCULAR DISEASE RISK**

**Purpose**

- To present a fully automated software system for detection of hypertensive retinopathy (HR) in digital fundus images, and to investigate its potential as a tool in estimating the 10-year cardiovascular disease (CVD) risk.

**Background**

- The US has 310,000 annual incidences of heart attack; 795,000 people experience a stroke.

- Signs of hypertensive retinopathy (HR) such as retinal abnormalities present an early indication of increased risk of incident heart failure and stroke.

- Regular screening for signs of HR can predict long-term risks for cardiovascular disease (CVD) or stroke.

- A fully automated software for detection of HR can make wide-spread CVD risk estimation using fundus photographs possible.

- Our innovative system integrates the automated HR screening software with a low-cost, portable retinal camera to make screening available at primary healthcare facilities.

**System Description**

- A fully automated software tool, "Comprehensive Assessment of Retinal Vasculature" (CARV) was developed to characterize the retinal abnormalities associated with HR, using methods for:
  - Quantification of vessel morphology
  - Detection of five retinal abnormalities

- The system processes two processing levels (Fig. 2):
  - Retinal vessel network analysis
  - Retinal morphology measurement and abnormality detection

**Methods**

- Copper and silver wiring (Fig. 4a)
  - Arterial vessel ridges formed by wiring are detected using histogram equalization and second order derivative of Gaussian.
  - Differential cross-sectional intensity profile of a vessel is analyzed to detect wiring (Fig. 4b).

**Results**

- The effectiveness of CARV software was evaluated in two ways: 1) As an HR detection system, 2) As a tool to estimate the 10-year CVD risk.

- HR detection:
  - A dataset of 25 patients was utilized in this study, with 15 patients with HR and 10 controls with no retinopathy. Each patient has 4 retinal images, standard two-field for each eye, Canon CR1 Mark II camera, 45° FOV.
  - We obtained the HR classification performance AUC of 0.83, maximum accuracy of 90%, and sensitivity/spcificity of 90%/73% against ground truth provided by a retinal grader.

- Estimation of 10-year CVD risk:
  - The Pearson’s correlation coefficient (r) between the 10-year ASCVD risk estimation and the probability of HR determined by CARV software was 0.64.

**Discussion**

- We present a fully automatic software system (CARV) for detecting retinal abnormalities of hypertensive retinopathy in digital fundus images.

- When used to detect the presence of hypertensive retinopathy, CARV achieved an AUC of 0.83 and sensitivity/specificity of 90%/73%.

- CARV was effective in estimating the 10-year CVD risk, as indicated by a moderate correlation of 0.44 between HR probability and CVD risk score. It demonstrates the potential of aHR detection system as a tool for estimating the associated risk of CVD.

**Conclusions**

- The fully automated hypertensive retinopathy detection software integrated with a low-cost retinal camera can provide the primary healthcare facilities with an easily accessible solution for routine screening of HR, encouraging the early detection of signs of undiagnosed CVD or stroke for people who are unaware of their risk.

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